PRESENTATION

The System of Readout Boards for ALICE TRD

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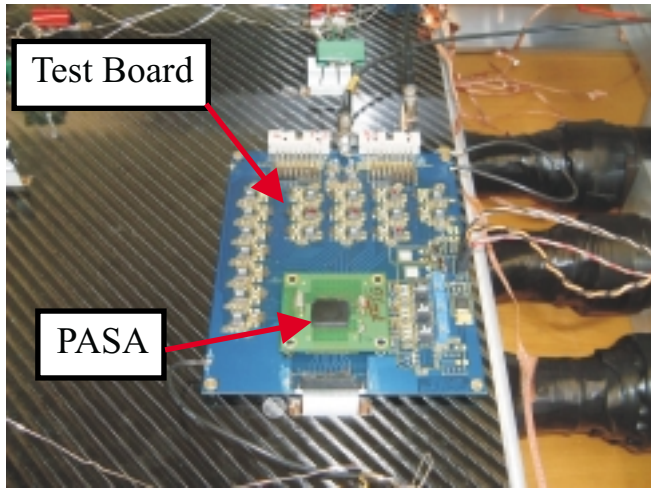
ALICE TRD: Charge Sensitive Preamplifier

(PASA Measurements - Dr. Ivan Rusanov; PI, Uni-Heidelberg)

The Chamber Measurements



The Characterizing Measurements:

1. TRD Charge Sensitive Preamplifier.
2. TPC Charge Sensitive Preamplifier.
3. CBM Charge Sensitive Preamplifier.

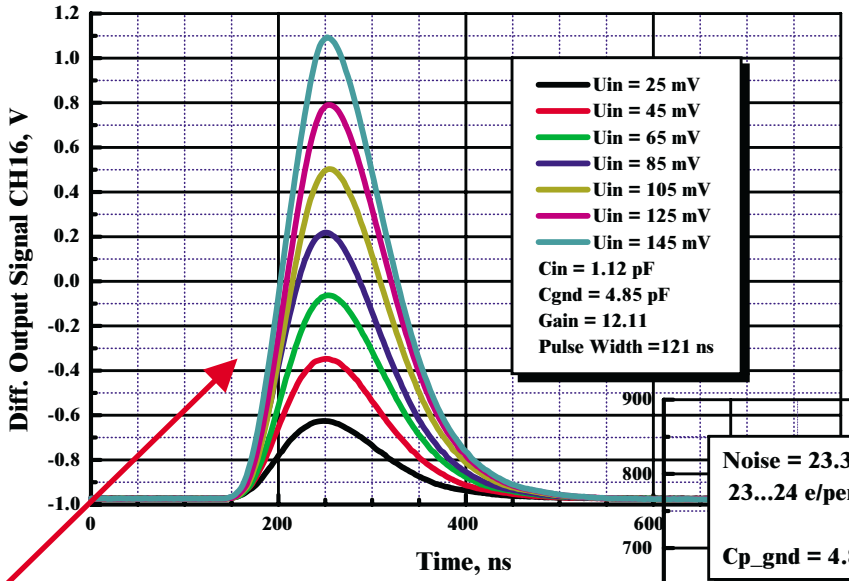
Measurements:

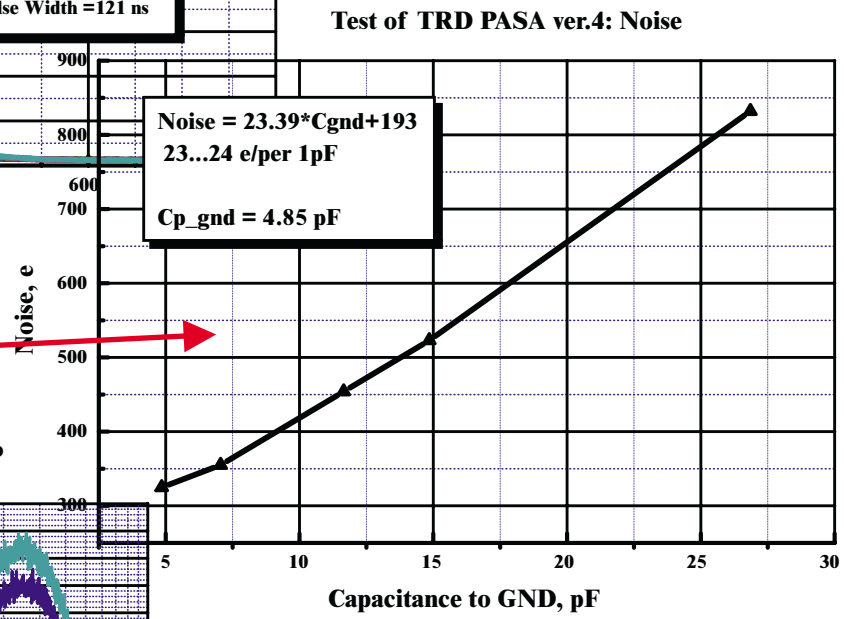
1. Gain, Pulse width => F=(Cin-gnd).
2. Pulses' Areas and Spectrum.
3. Base line and Crosstalk.
4. Noise => F=(Cin-gnd).

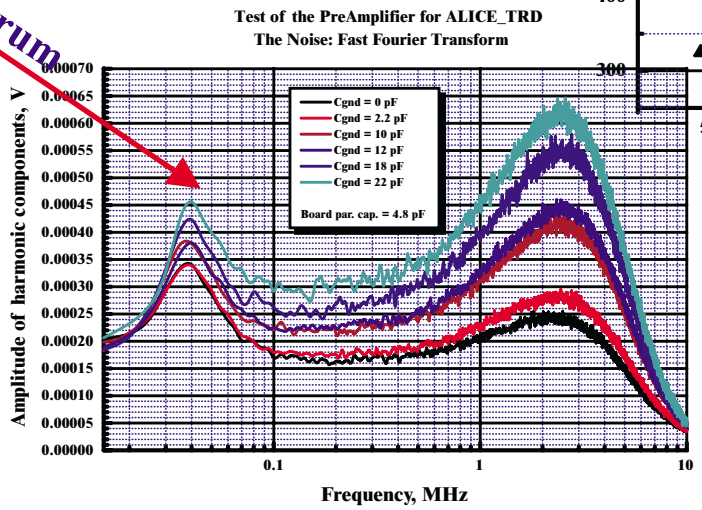
Pulses

Noise Measurement

Spectrum



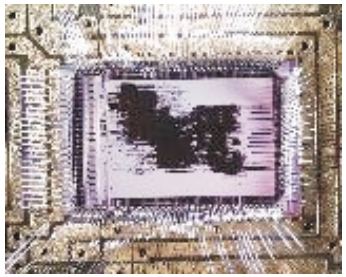


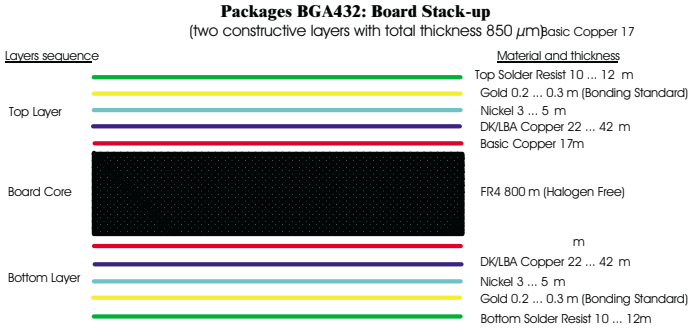

Test of the PreAmplifier for ALICE_TRD
The Noise: Fast Fourier Transform
Amplitude of harmonic components, V
Frequency, MHz
Cgnd = 0 pF
Cgnd = 2.2 pF
Cgnd = 10 pF
Cgnd = 12 pF
Cgnd = 18 pF
Cgnd = 22 pF
Board par. cap. = 4.8 pF

ALICE TRD: BGA 432 MCM Pakage

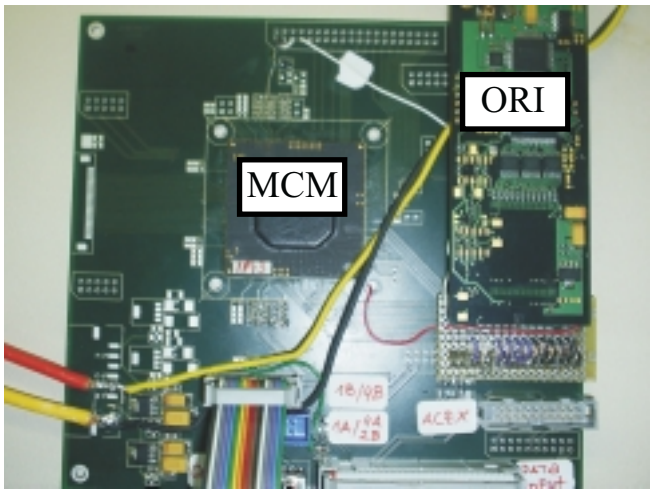
(Development and Design - Dr. Ivan Rusanov; PI, Uni-Heidelberg)

MCM Module




Packages BGA432: Board Stack-up
(two constructive layers with total thickness 850 µm)
Layers sequence
Material and thickness
Top Solder Resist 10 ... 12 m
Gold 0.2 ... 0.3 m (Bonding Standard)
Nickel 3 ... 5 m
DK/LBA Copper 22 ... 42 m
Basic Copper 17m
Top Layer
Board Core
FR4 800 m (Halogen Free)
m
DK/LBA Copper 22 ... 42 m
Nickel 3 ... 5 m
Gold 0.2 ... 0.3 m (Bonding Standard)
Bottom Solder Resist 10 ... 12m
Bottom Layer
Basic Copper 17

Single MCM Test Board



The package for the ALICE TRD MCM module is custom-made printed circuit board:

Package Type:	BGA432, 31x31 pads in 4 rows.
Board Outline:	41.15 x 41.15 mm.
Layers:	2 Constructive layers.
Core material:	FR4, 0.8 mm, Halogen free.
Basic Copper (Thickness):	0.017 mm.
Finish:	Chemical gold, Bonding Standard.
The finished board thickness:	0.8 mm Tolerance +/- 0.1 mm.
Solder mask:	Double sided (green).
Silkscreen:	Yes. Only top layer.

Board Design rules:

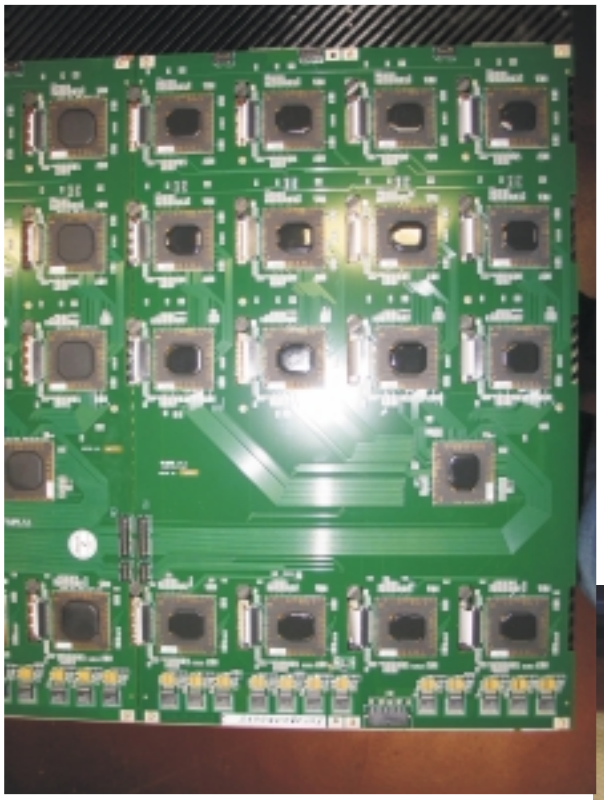
Minimum route width:	0.12 mm.
Via size:	0.55 mm.
Drill diameter:	0.2 mm.
Minimum spacing:	0.08 mm
Ball Pitch:	1.27 mm.
Ball Diameter:	0.75 mm.
Ball Composition:	63%Sn / 37%Pb.

Bonding rules:

Chip-to-Chip:	The PASA's outputs to ADCs' inputs.
Chip- to boards:	All other signals.

ALICE TRD - Readout Board System

(Development and design - Dr. Ivan Rusanov; PI, Uni-Heidelberg)



Readout Boards (Type 1B)

- 7 different 6-layers ROBs with:
2 signal layers - LV TTL and LVDS.
4 power planes - 3 GNDs and 12 PSVs.

- The ROBs are with mixed signal integrity.

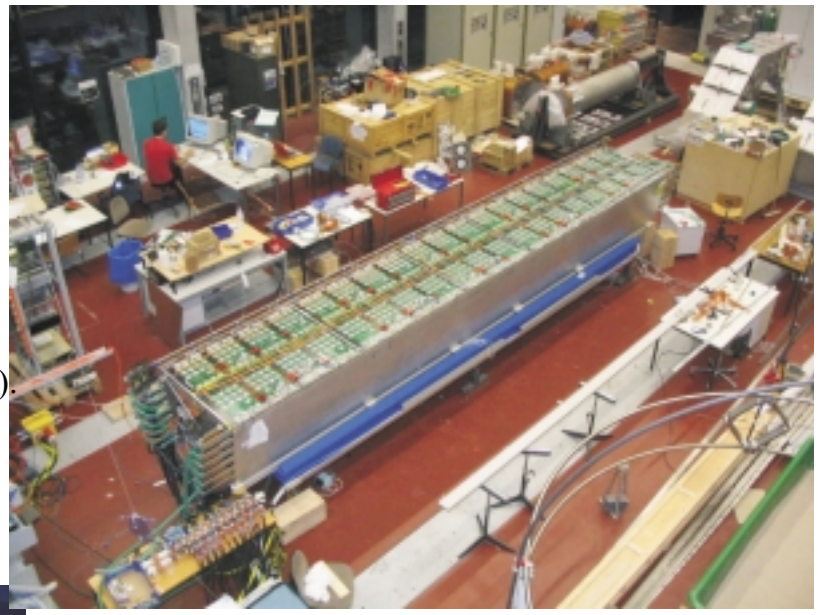
Average Noise Level: ~ 0.5 LSB / 500 e.

ALICE TRD Chambers

- In the ALICE TRD there are chambers with:
12 pad rows in 6 different dimensions (6 ROBs).
16 pad rows in 6 different dimensions (8 ROBs).

- In order to minimize the number of different ROBs:
The ROBs have the same board outline (460x300 mm).
The fixed positions of the MCM modules.
The same essential functions.

Average Noise Level: ~ 1.3 LSB / 1300 e.



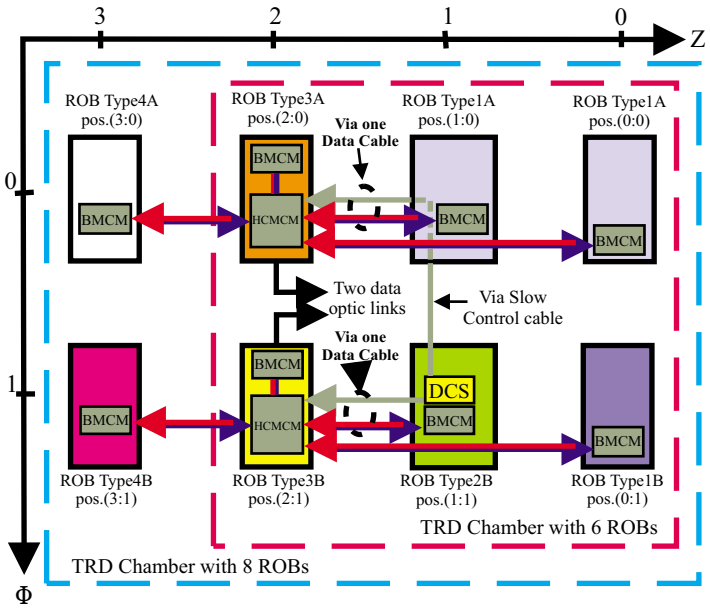
ALICE TRD Super Module

- Each Super Module includes:
30 TRD Chambers.
30 HV Filter Boards.
228 Readout Boards.
24 LV Filter/Protection Boards.
678 Cable Boards, connecting the ROBs within one TRD Chamber.
and additional boards and services.

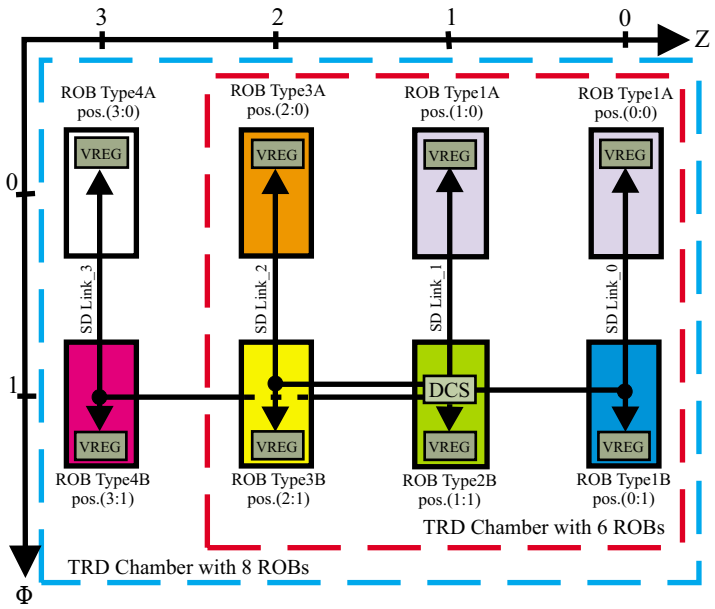
ALICE TRD - Readout Board System

(Development and design - Dr. Ivan Rusanov; PI, Uni-Heidelberg)

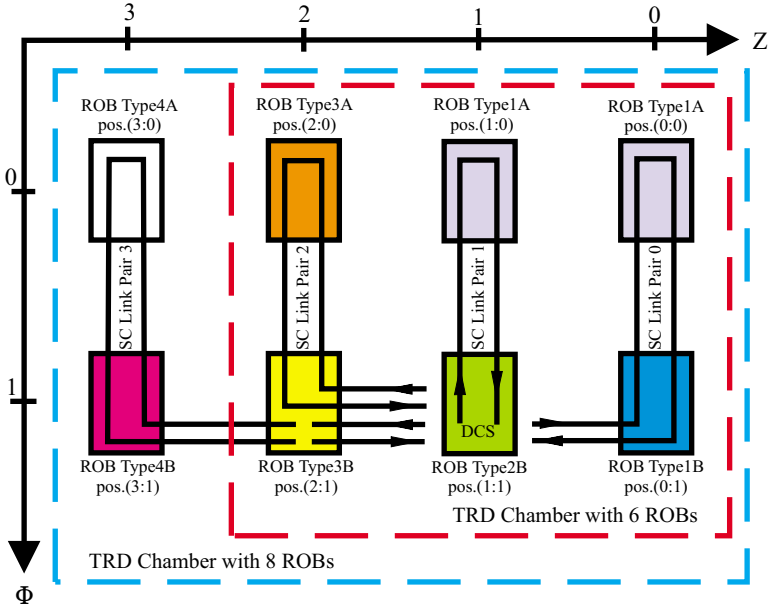
Data, CLK, Trigger and Reset distribution



Shutdown links



Slow Control Serial Network



1. The ALICE TRD Readout Boards' System includes three networks:
- DATA, CLK, TRIGGER and RESET.
- Slow Control Serial Network.
- Shutdown links.
2. Each ALICE TRD Super module includes two different chamber types in 6 different dimensions per type.

The Design Strategy

1. All ROBs have the same board outline (460x300 mm) and fixed position of the MCM modules.
2. The ROBs have the same essential functions: amplifying, shaping, digitizing and DATA sending. The additional functions have only those ROBs, which include the "half chamber merger" (3A and 3B) and DCS board (2B).
3. The DATA transfer is done only in Z direction (A side and B side).
4. Two ROBs in Phi always belong to one SCSN Link Pair.
5. The same two ROBs are controlled by one SD link. The SD signals follow the ways of SCSN signals

The Result

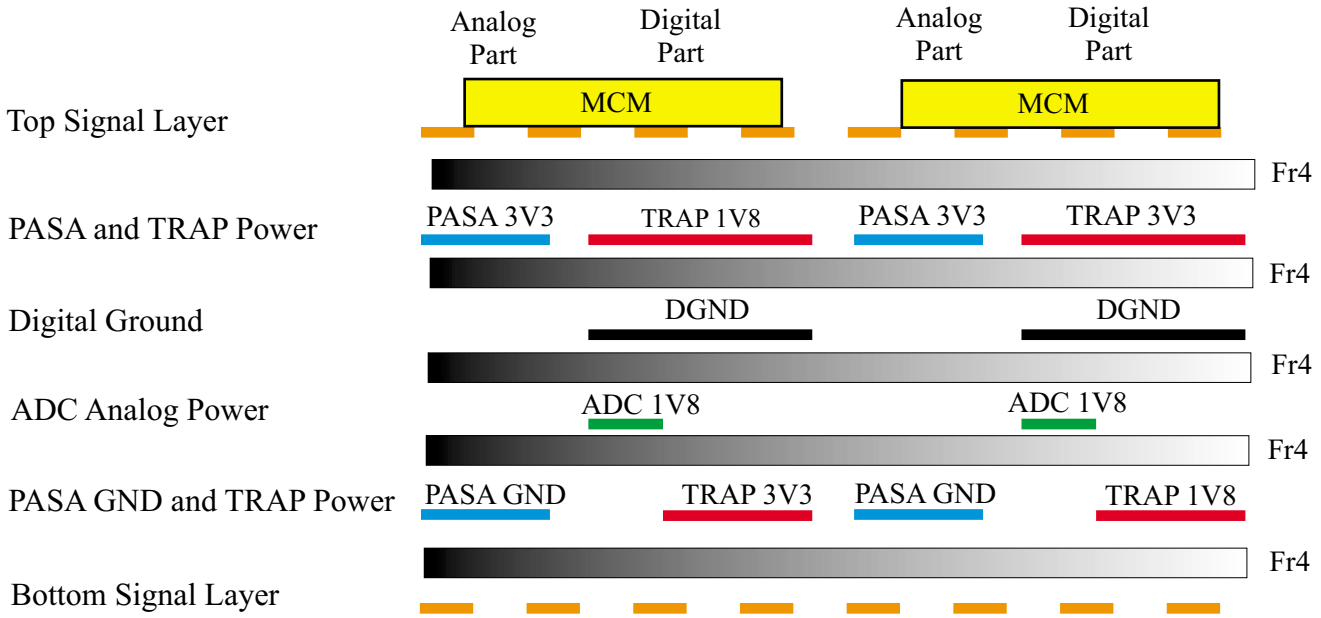
4. With this strategy of development was designed the universal ALICE TRD Readout Boards' System, which:
- Covers the general ALICE TRD requirements.
- Can equip both of TRD chambers types (with 12 or 16 pad rows) with minimum connection between Readout Boards.

Important: In case of TRD Chamber with 12 pad rows the ROB Type 4A/4B are not used.

ALICE TRD - Readout Board System

(Development and design - Dr. Ivan Rusanov; PI, Uni-Heidelberg)

Readout Board: Distribution of the Power Supply Voltages and Grounds



1. Each Readout Board connects 17 or 18 MCMs (Type 3A/3B - ORI Board, Type 2B - DCS Board).

2. The ROB includes 12 reference voltage domains (2 x3.3V PASAs, 2x1.8V ADCs, 3x3.3V and 5x1.8V TRAP digital).

3. The Ground domains - Analog PASA Ground, Analog and Digital ADCs Grounds, and Digital TRAP Ground:

- The ADCs Grounds and TRAP Ground are joined below each MCM module in one ROB's Digital Ground (DGND).
#The Partially Connected Islands#.
- The PASA Ground (PASA GND) and ROB's digital ground are fully separated.
They are joined by the "Common Ground Connection: ROB to TRD Chamber".

The advantages:

1. The minimizing of over lapping.

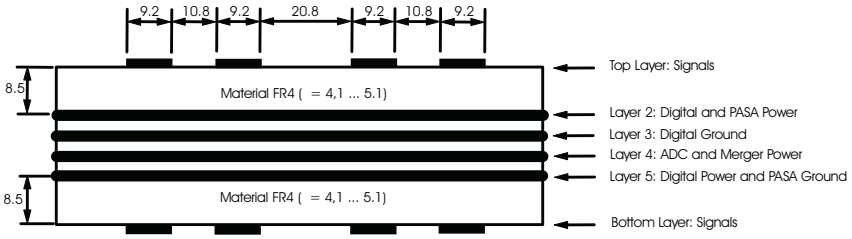
2. A minimizing of a parasitic connection between analog part of MCM and Power planes. The analog part of each MCM is always over the PASA power supply domain.

3. The analog signals are over the PASA power and ground domains.

4. The LVDS signals are over the TRAP power domains.

5. The power supply and ground domains of each MCM-column are separated from the other columns.

READOUT BOARD: Structure of the LVDS Lines



* Dimensions are in thousandths of inch.

Readout Board:

1. Copper Thickness: 0.017 mm.
2. LVDS Lines: Edge-Coupled Surface Microstipline.
3. Diff. Impedance: 100 Ohm + 10 % (copper thickness 0.017 mm).

ALICE TRD - Readout Board System

(Development and design - Dr. Ivan Rusanov; PI, Uni-Heidelberg)

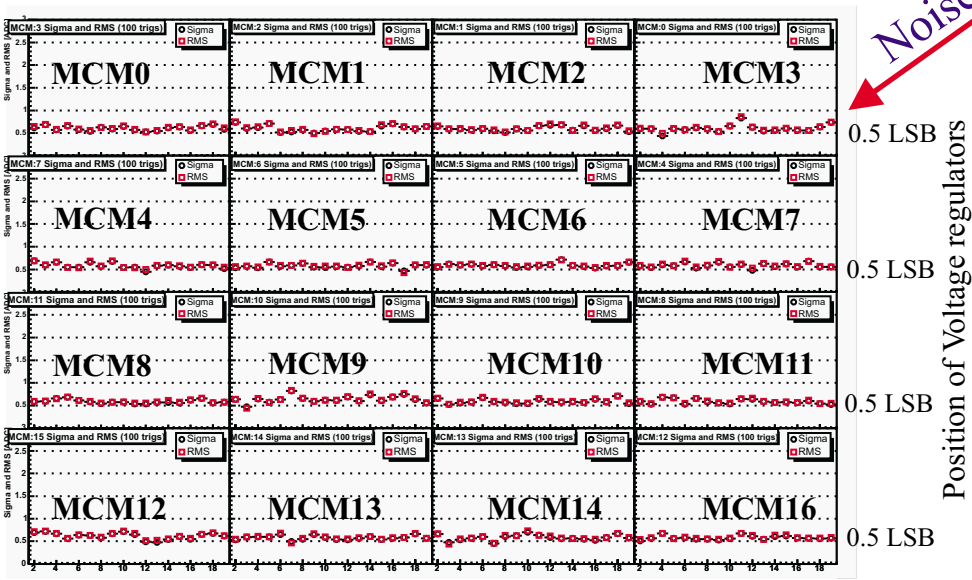
READOUT BOARD: Testing and Improvement

READOUT BOARD: Full Functional Test

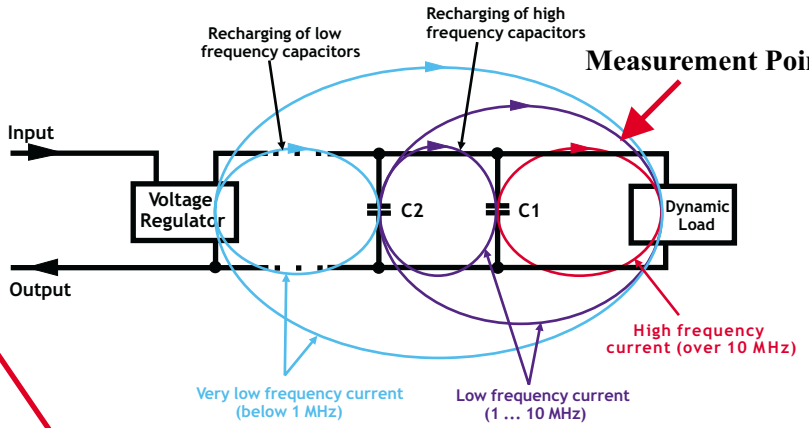
Noise

Theory

Consumption



Power supply schematic of Dynamic Load



The Current Profiles Measurement

Fixing of quantities and characteristic of the decoupling capacitors (C1 and C2)

New Full Functional Test

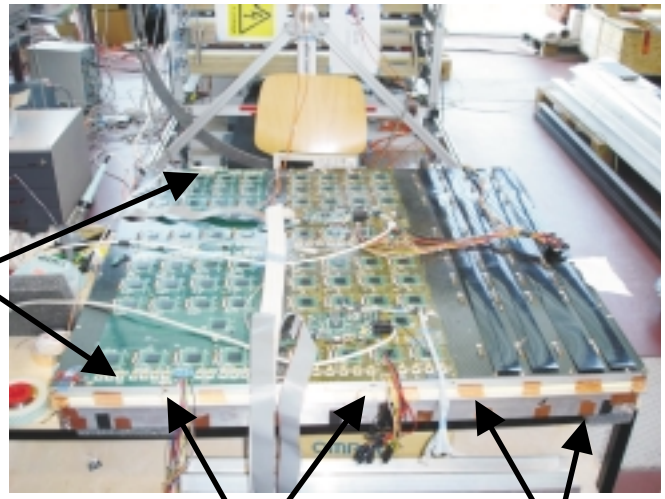
1. Small changes in ROB's PCB Layout.

2. The Pre-series Production could be started.

ALICE TRD: Chamber Grounding Scheme

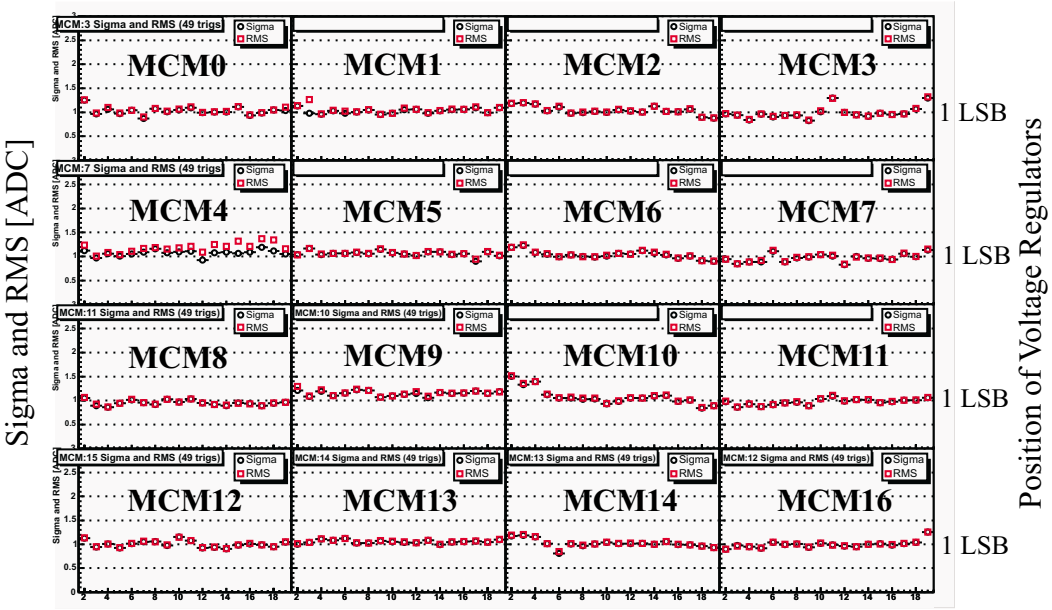
(Development and improvement - Dr. Ivan Rusanov and Dr. Ken Oyama; PI, Uni-Heidelberg)

The noise measurement: ROB Type 4

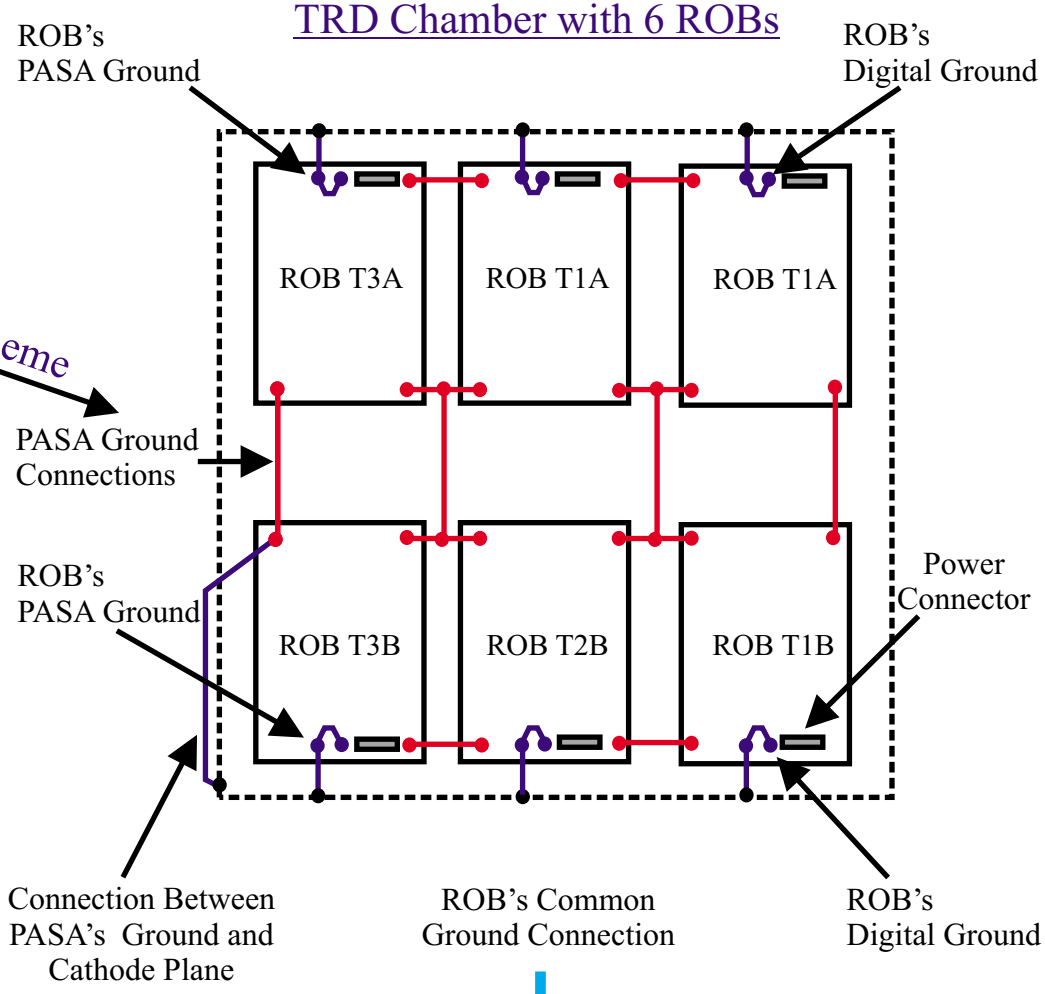


Final Grounding scheme

Noise: ~ 1 LSB



TRD Chamber with 6 ROBs

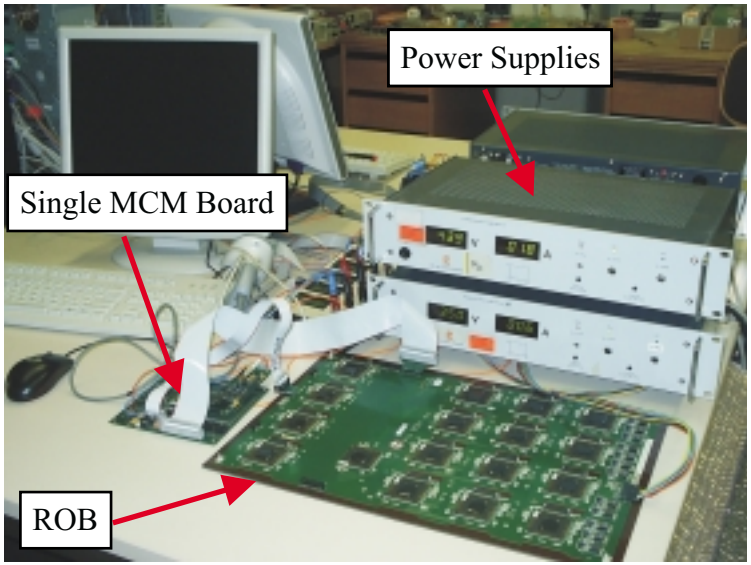


Average Noise Level: ~ 1.3 LSB / 1300 e.

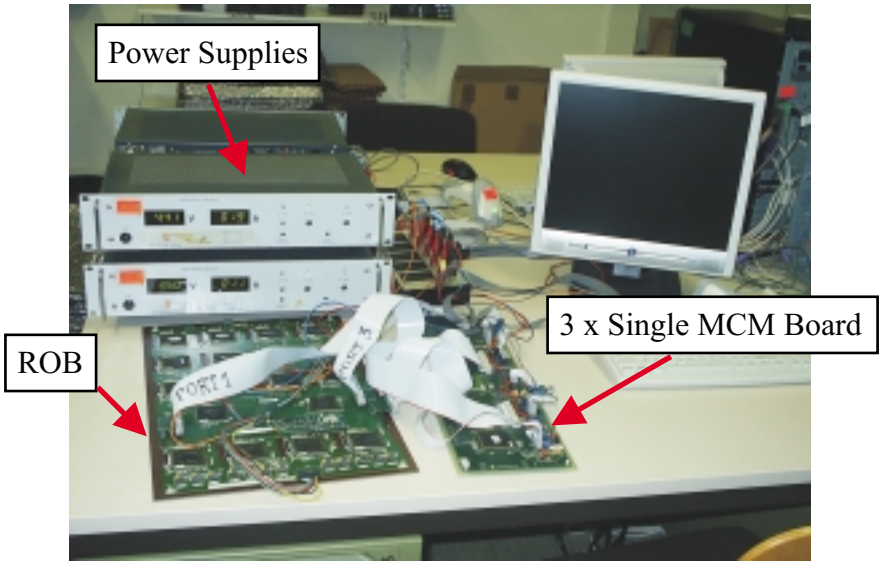
ALICE TRD - Readout Board System

(Testing - Dr. Ivan Rusanov [hardware] and Jorge Mercado [software]; PI, Uni-Heidelberg)

ROB Tester: Type 1A/B, 2B and 4A/B



ROB Tester: Type 3A/B



1. Two test setup were developed:
The first is for the testing of ROBs Type 1A/B, 2B and 4A/B.
The second - ROBs type 3A/B.

2. With the test setups could be done full functional and connectivity tests of each ROB type.

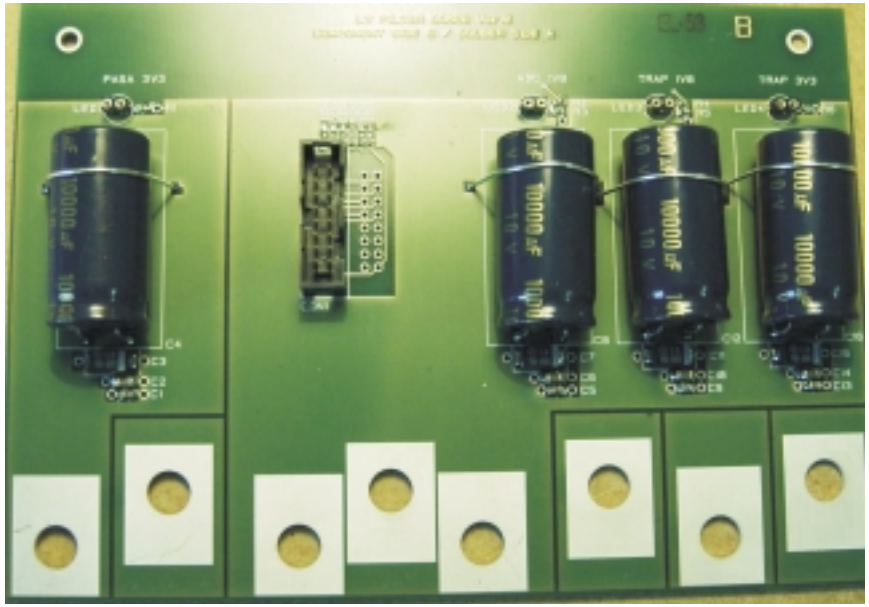
3. For each produced ROB, before testing, is done “thermo cycle training”.

4. The discovered soldering problems are provided to the ROB's producing company:

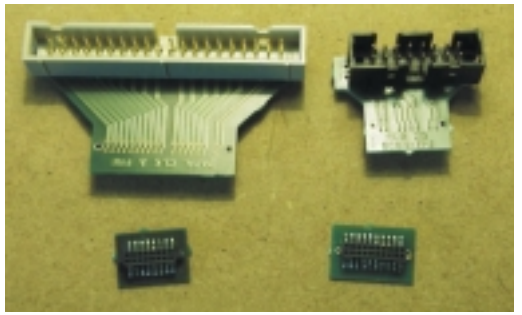
ALICE TRD: Additional Boards

(Development and Design - Dr. Ivan Rusanov; PI, Uni-Heidelberg)

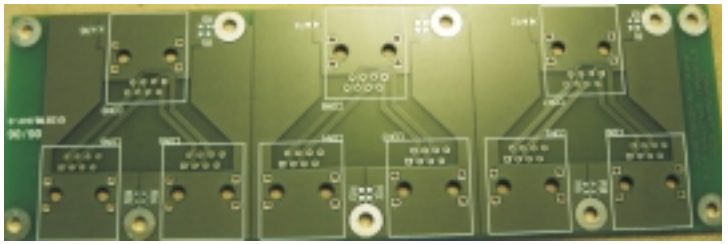
LV Protection/Filter Boards



Cable Adapters



Ethernet Y-Shape Boards



HV Filter Boards

Cables Boards